Poisonings with pesticides in the Federal District of Brazil

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Introduction. Pesticides are the second major cause of poisoning in Brazil, but information about the chemicals involved and the clinical management of patients is scarce. Methods. This study is a retrospective review of 709 pesticide cases reported to a toxicological information center from 2004 to 2007. Results. Over 90% of the cases occurred after accidental or self-poisoning; more than 60% of the accidents involved children up to 4 years old, mainly with domestic pyrethroid insecticides. One hundred ninety-four cases involved chumbinho, an illegal rodenticide known to contain acetylcholinesterase inhibitor insecticides, mainly aldicarb. In about half the cases, the individuals were admitted to hospitals. Those poisoned with acetylcholinesterase inhibitors stayed longer and most of them displayed pronounced clinical signs of poisoning (Poisoning Severity Score grades 2–4); 14 of the 18 deaths reported occurred with these products. Atropine was given to about 30% of the individuals, including to some with no cholinergic symptoms or exposed to non-acetylcholinesterase inhibitors. All 81 poisonings with coumarin were asymptomatic, but in half of the cases the individuals received vitamin K. Conclusions. The lack of laboratory support to confirm the chemical involved in the poisonings certainly contributed to the unnecessary antidote administration. In spite of continuing government efforts, poisoning with chumbinho is still a major problem in the country.

Keywords Pesticide; Acute poisoning; Organophosphate; Carbamates; Chumbinho

Introduction

Pesticide poisoning is a major public health problem in some countries. The International Labor Organization estimates that pesticides annually cause 70,000 fatal and a much larger number of non-fatal poisonings among agricultural workers (1). Gunnell et al. (2) estimated that between 233,997 and 325,907 deaths occur each year from pesticide self-poisoning, accounting for about one-third of suicides globally. Pesticide exposure represents a human health problem in developing countries, mostly because of the availability of highly toxic compounds and the unsafe use, storage, and disposal of the products (3). According to the Brazilian National Poisoning Information System (4), more than 8,000 cases of poisonings with pesticides are reported each year in the country, accounting for 34.4% of all deaths from exogenous poisoning in 2005. Pesticides were involved in 7.7% of all fatal suicides that occurred in 2005 in Brazil (5).

The Brazilian pesticide market has grown steadily in the last decades, doubling its sales between 1996 and 2006, placing it fourth in the worldwide ranking (6). By January 2008, about 1,300 formulations were registered for agricultural use in the country, 42% of which were classified by the Brazilian government as extremely or highly toxic (7). Brazil has pesticide legislation that regulates all aspects of pesticides, including registration, commerce, and use (8). Legally, no pesticide can be sold without the presentation of an agronomic prescription issued by technical personnel, and its use in the field requires formal training. However, the law is poorly enforced, especially in certain remote regions of the country. One major example of pesticide misuse is the illegal rodenticide called chumbinho (small shot) formulated with registered agricultural products, mainly aldicarb. In Brazil, all registered rodenticides are coumarin compounds, which include the first generation hydrocoumarin warfarin (coumafene), coumachlor, and coumatetralyl, and the second generation long-acting rodenticides (LAAR) brodifacoum and bromadiolone (9).

The aim of this study was to characterize pesticide exposures in the Federal District, a predominantly urban area.
Methods

This is a retrospective study of data on pesticide exposures reported to the Center of Toxicology and Assistance of the Federal District (CIAT-DF) between 2004 and 2007. Information gathered by the Center was put into a “report card” and transferred into an Epi-info/2000 computer program for analysis. Information included the date and circumstances of the exposure, the chemical(s) involved, sex and age of the patient, hospital admission, clinical effects, medical management, laboratory data, and outcome. Whenever information was incomplete or unclear in the Center records, additional data were obtained from the patient record at the hospital where the patient was treated. When information was not available, it was classified as ignored.

Results

A total of 709 poisoning cases involving pesticide products were reported to the CIAT-DF during the study period, 62.8% through telephone calls and 37.2% through hospital epidemiological units. The cases were evaluated together in this study. Thirteen cases also involved medications and 10 cases involved ethanol. The most common exposure route was ingestion (84%), with fewer numbers via the dermal or respiratory route. The majority of cases occurred at the domicile (91%), among individuals living in urban areas (86.3%), and among men (51.4%). Unintentional poisoning and self-poisoning accounted for 47 and 44% of the cases, respectively. Occupational poisoning occurred in 35 cases. Other known circumstances were inappropriate use (nine cases), food contamination (six cases), homicide/violence (three cases), and abortion (two cases). The circumstances were unknown in 45 cases.

Almost one-third of the cases occurred in children aged 1–4 years, 94.5% of which were unintentional exposures. Two of the nine cases in children ≤1 year of age involved homicide/violence. Most of the self-poisoning cases (54.3%) occurred in individuals aged 15–29 years; in 14 cases they were 10–14 years old. Women represented 54.2% of the self-poisoning cases; this circumstance was involved in 18 of the 23 cases where the pesticide was ingested with medications or ethanol. The majority of the cases occurring during occupational activity involved men between the ages of 20 and 39 years.

Chemicals in poisoning cases

Table 1 shows the distribution of the poisoning cases according to the circumstance and the chemical involved. A total of 51 compounds were identified from the reports; the most frequent were aldicarb, chlorpyrifos, cypermethrin, and brodifacoum. In 155 cases, neither the chemical group nor the

Table 1. Chemical group/name and the circumstances involved in intoxication cases in the Federal District reported to the CIAT-DF from 2004 to 2007

<table>
<thead>
<tr>
<th>Chemical group</th>
<th>Compound</th>
<th>Total</th>
<th>Accidental</th>
<th>Self-poisoning</th>
<th>Occupational</th>
<th>Others/ignored</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chumbinho&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>194</td>
<td>67</td>
<td>111</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>Coumarin</td>
<td></td>
<td>82</td>
<td>39</td>
<td>41</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Brodifacoum</td>
<td>35</td>
<td>17</td>
<td>18</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Brongadiolone</td>
<td>18</td>
<td>11</td>
<td>6</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Others/ignored</td>
<td>28</td>
<td>11</td>
<td>17</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pyrethroid</td>
<td>Cipermetrin</td>
<td>78</td>
<td>49</td>
<td>23</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Deltamethrin</td>
<td>49</td>
<td>22</td>
<td>19</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Others/ignored</td>
<td>20</td>
<td>12</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Organophosphate</td>
<td>Chlorpyrifos&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Dichlorvos&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Others/ignored</td>
<td>40</td>
<td>9</td>
<td>20</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Carbanates</td>
<td>Carbofuran</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Aldicarb</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Others&lt;sup&gt;c/ignored&lt;/sup&gt;</td>
<td>13</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>Ignored</td>
<td>52</td>
<td>19</td>
<td>18</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Total&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td>709</td>
<td>314</td>
<td>295</td>
<td>35</td>
<td>65</td>
</tr>
</tbody>
</table>

<sup>a</sup>Aldicarb associated or not with organophosphate.

<sup>b</sup>Include two associations with cypermethrin.

<sup>c</sup>Include three associations with cypermethrin.

<sup>d</sup>Total of poisoning cases.
chemical name was reported; some were identified by general terms such as rodenticide, insecticide, or poison.

More than half of the 276 cases involving rodenticides were because of self-poisoning, mainly (70.3%) with the illegal chumbinho, a product prepared mostly with aldicarb (Table 1). Eighty-two cases involved coumarin rodenticides, mostly brodifacoum and bromadiolone (53 cases). In at least 13 cases, other illegal rodenticides were involved, including two products reported to contain strychnine and sodium monofluoracetate, compounds not registered in Brazil.

Pyrethroid insecticides (primarily cypermethrin and deltamethrin) were mostly involved in unintentional poisonings with domestic products (Table 1). Chlorpyrifos and dichlorvos the main organophosphates (OPs), and carbofuran the main carbamate insecticide involved in the poisonings, were mostly formulated for agricultural use. The organochlorine pesticides such as aldrin, DDT (1,1,1-trichloro-2,2-bis (4-chlorophenyl)ethane), and lindane (gamma-hexachlorocyclohexane) were involved in nine poisoning cases. Other pesticides included glyphosate and almitraz, involved in 9 and 14 cases, respectively.

A total of 18 deaths were reported during the period, with a total case fatality rate (CFR) of 2.5%. Fourteen cases involved AChE inhibitors, and 10 cases involved chumbinho. Considering only the 280 cases involving AChE inhibitors (including seven associated with pyrethroids), the CFR was 5.0%; a similar rate was found when only the 194 chumbinho cases were considered (5.2%). Fifteen fatal cases were because of self-poisoning by adults between 17 and 60 years of age, including one associated with medication and one with ethanol. Three fatalities were unintentional – one involving a 3-year-old child poisoned after playing in the home garden recently treated with thiamethoxam; one involved a 9-year-old child poisoned with an unknown ant killer in the house; and the third one involved the unintentional ingestion of chumbinho by a male of unknown age.

Clinical symptoms and medical management

In 14 reported cases, calls were made to the Center by individuals asking how to treat the intoxication. Most of these cases involved mild exposures through respiratory or dermal route. Headache and nausea were the main symptoms reported. In general, the individuals were told to seek fresh air and/or wash the exposed body area, and to seek medical advice if the symptoms persisted.

Intoxicated individuals took between 5 min and 5 days to seek medical assistance after the first effects occurred. Almost half were admitted to hospitals where they stayed from 1 to 33 days. Fig. 1 shows the distribution of the main chemical groups involved in the reported poisoning cases, according to hospital admission and period of stay, when this information was available. Over 60% of the individuals poisoned with AChE inhibitors and coumarin compounds were admitted to hospitals, most of them staying for a maximum of 2 days. Over 20% of the individuals poisoned with AChE inhibitors who required admission to a hospital stayed for over 5 days. Thirty-six percent of the individuals poisoned with pyrethroids were admitted to a hospital, most of them staying for only one day (Fig. 1).

Table 2 shows the Poisoning Severity Score (PSS) of the reported cases based primarily on symptoms (10). Over 70% of all cases, 76.1% of the pyrethroid cases, and over 90% of the cases with ignored agent had no symptoms or signs related to poisoning (score 0) or were classified as minor severity (score 1). Over 50% of the 280 cases with AChE inhibitors

![Fig. 1. Percentage of individuals admitted to hospitals (poisoned individuals) and time of stay (of individuals admitted) according to compound classes.](image-url)
(carbamate and OP) were classified as moderate, severe, or fatal.

The main muscarinic symptoms reported by individuals intoxicated with AChE inhibitors were miosis, salivation, and vomiting (22–33% of the patients exposed to these compounds). Sweating and tachycardia were the main nicotinic symptoms reported, and agitation the main neurological symptom. In over 20% of the cases involving other or unknown chemicals, individuals reported cholinergic symptoms, including vomiting, miosis, bronchorrhea, tachycardia, and salivation.

The hospital medical management of patients exposed to *chumbinho*, OP, or carbamate compounds is shown in Table 3. Fifty-one patients who received atropine did not show any muscarinic symptoms, 18 of whom were exposed unintentionally, and 11 reported being exposed to non-AChE inhibitors or to unknown compounds. All 14 individuals who died after AChE inhibitor ingestion received atropine at the recommended dose (2–4 mg every 15 min), and three also received an oxime.

Typical symptoms reported by 7–19% of the individuals after oral ingestion of pyrethroids evaluated in this study included vomiting, miosis, bronchorrhea, tachycardia, and salivation.

Table 2. Poisoning severity score

<table>
<thead>
<tr>
<th>Group</th>
<th>(0)</th>
<th>Minor (1)</th>
<th>Moderate (2)</th>
<th>Severe (3)</th>
<th>Fatal (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbamate/OP</td>
<td>11</td>
<td>124</td>
<td>69</td>
<td>62</td>
<td>14</td>
</tr>
<tr>
<td>Coumarin</td>
<td>77</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pyrethroids</td>
<td>22</td>
<td>90</td>
<td>12</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>9</td>
<td>25</td>
<td>7</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Ignored</td>
<td>43</td>
<td>98</td>
<td>9</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Total (%)</td>
<td>162 (22.8)</td>
<td>342 (48.2)</td>
<td>97 (13.7)</td>
<td>90 (12.7)</td>
<td>18 (2.5)</td>
</tr>
</tbody>
</table>

(0), no symptoms or signs related to poisoning; (1), mild, transient, and spontaneously resolving symptoms; (2), pronounced or prolonged symptoms; (3), severe or life-threatening symptoms; and (4) death.

Table 3. Management of patients poisoned with AChE inhibitors

<table>
<thead>
<tr>
<th>Group</th>
<th>Antidote</th>
<th>Decontamination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Atropine</td>
<td>An oxime</td>
</tr>
<tr>
<td><em>Chumbinho</em>, 194</td>
<td>122 (62.9%)</td>
<td>22 (11.3%)</td>
</tr>
<tr>
<td>Organophosphate, 62b</td>
<td>35 (56.4%)</td>
<td>16 (25.8%)</td>
</tr>
<tr>
<td>Carbamate, 24c</td>
<td>17 (70.8%)</td>
<td>0</td>
</tr>
</tbody>
</table>

The number of individuals are expressed in percentage (%). The percentage is relative to each group of poisoned individuals.

*aPercentage relative to those orally exposed only.

*bInclude four associations with pyrethroids.

*cInclude three associations with pyrethroids.

Discussion

The profile of pesticide poisoning cases reported to the CIAT-DF is consistent with what has been found at the national level in recent years by the SINITOX (5,11). The total CFR found here was similar to what was reported in 2005 for other areas in the Midwestern region (2.4%); at the national level, the rate was 1.8%, but reached 4.1% in the Northeastern region of the country. These rates are higher than what was found in England and other developed countries (up to 0.5%), but much lower than in some Asian countries, where the CFR for OP compounds may reach 45% (12).
The number of poisoning cases reported to the Brazilian toxicological information centers, however, is highly underestimated (11,12). The under-reporting in the Federal District is clear when one compares the fatal cases involving pesticides reported to the CIAT in 2005 (three cases) with those reported to the National Mortality Information System (19 cases) (5). Hence, the data presented here may not be representative of all poisoning cases that occurred in the Federal District during the period of the study.

Chumbinho, a major product involved in the poisonings, was responsible for almost one-third of all cases with a known chemical group. This product was also the most lethal, with a CRF higher than what was found for this product in Rio de Janeiro in 1993 (4%) (13). Chumbinho contains primarily aldicarb (13,14), registered in Brazil for soil application on potato, coffee, sugar cane, and citrus farms. Aldicarb can only be commercialized in the states of São Paulo, Minas Gerais, and Bahia, but chumbinho is sold illegally with no label in most Brazilian cities. Physically, chumbinho is characterized as small gray-colored bullets, which can be found in the gastrointestinal tract following large ingestions (14).

This product was first introduced in the country in the city of Rio de Janeiro during the mid-1980s, and acute poisoning with this illegal product has been a major problem in many Brazilian urban centers since then. In 1993, 189 cases were referred to the Poison Control Center of Rio de Janeiro (13); between 2000 and 2002, chumbinho caused over 300 deaths in the city (14). In the Northeastern state of Bahia, nearly 4,000 individuals were poisoned with chumbinho between 2000 and 2006, mostly because of self-poisoning (15). In the Northern state of Pará, almost 80% of the 158 reported self-poisoning cases that occurred between 1998 and 2001 involved chumbinho (16).

In an attempt to reduce the incidence of poisonings with chumbinho in the country, the manufacturer of aldicarb, following recommendation from the Brazilian Government, has included a bittering agent in the product since 2002. The addition of a colorant and an emetic in the formulation has also been considered by the Government, which also increased the market control over the product (17). These actions have led sellers to use other less restricted pesticides in chumbinho preparation. In a study to identify the compounds present in illegal granular rodenticides sold in 2004/2005 in free markets of Belém, in the north region of the country, 55% of the 120 samples analyzed by thin layer chromatography gave positive results for carbamate, 20% for OP, 15% for carbamate and OP, and 5% for coumarin compounds (18). Currently, there are no available data to estimate whether the poisoning cases involving chumbinho have changed in the country in the last years or whether the use of less toxic compounds in the product has decreased its CFR. We did not find any specific trend on the number of chumbinho cases in the Federal District over the years; the higher CFR occurred in 2006 (13%).

Poisonings from exposure to insecticides illegally used for rodent control have been reported elsewhere. Lifshitz et al. (19) evaluated 35 cases of ingested rodenticide containing methomyl or aldicarb resulting in carbamate poisoning that occurred in Israel between 1985 and 1995. In 2001, Nelson et al. (20) reported 35 cases referred to the New York City Poison Control Center that involved the ingestion of Tres Pasitos, a rodenticide shown to contain aldicarb. All patients were originally from Dominican Republic, where the product is commonly available.

Diagnosis of AChE inhibitor poisoning should ideally be confirmed with an assay to measure butyrylcholinesterase (BChE) activity in plasma or AChE in erythrocytes (10,21). In Brazilian hospitals, these assays are rarely available and in the present study, plasma BChE activity was measured in only six patients exposed to AChE inhibitors. Analytical confirmations of the involved chemicals were not performed in patient biological material or for any of the products involved in the poisoning cases. Hence, unless clinical signs clearly indicated otherwise, product information was obtained from the patient or a person responsible for the patient. In a study conducted in a Japanese Medical School Hospital, the results of analysis were consistent with the information provided by the patient in 72% of 96 cases of intoxication with pesticides; in the remaining cases, either no information was obtained upon consultation, or the results of analysis were not consistent with the information provided (22).

Over 50% of the patients exposed to AChE inhibitors displayed pronounced clinical signs of poisoning (PSS grades 2–4), but the frequency of cholinergic effects was low compared to other reports. In a study of 30 patients with confirmed ingestion of chumbinho admitted to the emergency of a university hospital in Rio de Janeiro, 15 to over 90% of patients showed muscarinic signs (23). Similar results were found by Saadeh et al. (24) when evaluating 70 adults poisoned with carbamate or OP pesticides. In the cases involving Tres Pasitos in the USA, 71% of the patients reported miosis, 54% salivation, and 51% lethargy or coma (20). It is possible that not all individuals considered having ingested AChE inhibitors in the present study were actually exposed, mainly when the cases involved preschool children (25).

In the present study, atropine was administered to 41 patients reported to be exposed to AChE inhibitors but they did not show any cholinergic signs. Eleven asymptomatic patients exposed to pyrethroids or to unknown compounds also received atropine. An oxime was administered to 22 individuals reported to have ingested chumbinho, a procedure not recommended for carbamate poisonings (26). All the coumarin poisoning cases evaluated in this study were asymptomatic. Asymptomatic poisonings occurred in the majority of the 16,109 cases involving coumarins in the United States (27). Clinically significant anticoagulation after a single small ingestion of coumarin compounds is actually found to be rare in most studies (28). In the guidelines recently published by the American Association of Poison Control Centers (29), gastric lavage is not recommended for patients.
exposed to LAAR and decontamination should be performed only with activated charcoal; administration of vitamin K is not recommended prior to evaluation for coagulopathy. In the Federal District, almost all LAAR-poisoned patients, including accidentally exposed children, received gastric lavage and vitamin K was administered to 35 patients with either normal prothrombin time or to patients with no laboratory results.

Conclusions

This paper indicates that poisoning with the illegal rodenticide *chumbinho* is a major problem in the Federal District area, following what has been occurring in other regions of Brazil. It is unlikely that the fatal poisonings with this product will decrease in the next years unless the main insecticide used in the *chumbinho* preparation is banned in the country. The size of Brazil and a limited surveillance program make it impossible to control the use of this illegal product in the country. The present study also showed that the management of the poisoned patients in the hospital was not always adequate, mainly with the unnecessary administration of antidotes. In some cases, appropriate patient management was compromised by the lack of laboratory support to confirm the chemical involved in the poisonings.

Acknowledgments

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References